

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number: **0 282 971 B1**

B2

(12)

EUROPEAN PATENT SPECIFICATION

- (45) Date of publication of patent specification: **28.12.94** (51) Int. Cl.⁵: **A61K 31/425, C07D 277/82, C07D 417/12, C07D 277/60, C07D 513/04, //(C07D513/04, 317:00,277:00)**
- (21) Application number: **88104100.8**
- (22) Date of filing: **15.03.88**

(54) **Substituted 2-aminobenzothiazoles and derivatives useful as cerebrovascular agents.**

(30) Priority: **16.03.87 US 26428**
25.01.88 US 143107

(43) Date of publication of application:
21.09.88 Bulletin 88/38

(45) Publication of the grant of the patent:
28.12.94 Bulletin 94/52

(84) Designated Contracting States:
AT BE CH DE ES FR GB GR IT LI LU NL SE

(56) References cited:
EP-A- 0 039 809
EP-A- 0 050 551
GB-A- 1 153 648
US-A- 2 019 529

NEUROPHARMACOLOGY vol. 24, no. 8, August 1985, pages 767-773, Oxford, GB; J. MIZOULE et al.: "2-Amino-6-trifluoromethoxybenzothiazole, a possible antagonist of excitatory amino acid neurotransmission-I"

(73) Proprietor: **WARNER-LAMBERT COMPANY**
201 Tabor Road
Morris Plains
New Jersey 07950 (US)

(72) Inventor: **Johnson, Graham**
1130 Bandera Drive
Ann Arbor
MI 48103 (US)
Inventor: **Pavia, Michael Raymond**
1508 Westminster
Ann Arbor
MI 48104 (US)

(74) Representative: **Mansmann, Ivo**
Gödecke AG
Patentwesen
Mooswaldallee 1-9
D-79090 Freiburg (DE)

Note: Within nine months from the publication of the mention of the grant of the European patent, any person may give notice to the European Patent Office of opposition to the European patent granted. Notice of opposition shall be filed in a written reasoned statement. It shall not be deemed to have been filed until the opposition fee has been paid (Art. 99(1) European patent convention).

EP 0 282 971 B1

NEUROPHARMACOLOGY vol. 24, no. 11, November 1985, pages 1085-1092, Oxford, GB; J. BENAVIDES et al.: "2-Amino-6-trifluoromethoxy benzothiazole, a possible antagonist of excitatory amino acid-neurotransmission-II"

CHEMICAL ABSTRACTS vol. 83, no. 7, 18 August 1975, page 504, abstract no. 58798w, Columbus, Ohio, US; & JP- A - 7518463 (SANKYO CO. LTD.) 26.02.1975

BULLETIN OF THE INSTITUTE FOR CHEMICAL RESEARCH 1950, page 69; H. FUKIMURA: "Pharmacological studies on various benzothiazol derivatives"

ARCHIVES INTERNATIONALES DE PHARMACODYNAMIE ET DE THERAPIE vol. 221, 1976, pages 75-86, Ghent, BE; E.F. DOMINO: "Search for new treatment approaches in schizophrenia: In vitro studies of potential N-methyltransferase inhibitors"

JOURNAL OF PHARMACOLOGY AND EXPERIMENTAL THERAPEUTICS vol. 108, no. 1, May 1953, pages 94-103, Baltimore, US; W.H. FUNDERBURK et al.: "Pharmacological properties of benzazoles. III. Effect of 2-Aminobenzothiazoles on the electroencephalogram"

CHEMICAL ABSTRACTS vol. 88, no. 11, 13 March 1978, page 483, abstract no. 74335b, Columbus, Ohio, US; S.C. MEHRA et al.: "Synthesis of some local anesthetics from 2-aminonaphthothiazole" & J. Chem. Eng. Data 1978, vol. 23, no. 1, pages 89,90

Description

The compounds of the instant invention are a series of 2-aminobenzothiazoles which are useful for treating cerebrovascular disorders.

5 The present invention relates to a method of using certain 2-aminobenzothiazoles and pharmaceutically acceptable salts thereof as agents in treating cerebrovascular disorders.

United States Patent 4,370,338 covers 2-amino-6-trifluoromethoxybenzothiazole as useful as an anti-convulsant, an anxiolytic, and a hypnotic. The compound is described in Chemical Abstracts 60, 692a, 1964.

10 Domino et al, in J. Pharm. Exp. Ther., 1952, 105, 486-497 and in 1953, 107, 356-367 have described the pharmacological action of substituted benzazoles as inducing paralysis.

Paris et al, in Chimie Therapeutique, 1973, 6 655-658 discloses certain 2-aminobenzothiazole derivatives as analgesics and antiinflammatories.

The present invention relates to the use of compounds I for the preparation of pharmaceuticals for the 15 cerebrovascular disorders described hereinbelow.

Stroke is one cerebrovascular disorder in particular which can be treated by the instant compounds. Disorders including, but not limited to, cerebral ischemia or cerebral infarction resulting from a range of conditions such as thromboembolic or hemorrhagic stroke can be treated by the instant compounds.

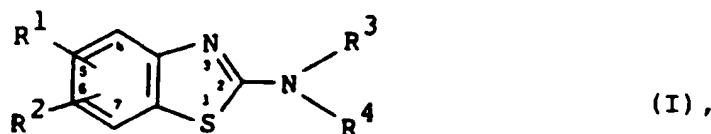
Compounds of Formula I can also be used as anesthetics especially in surgical operations where risk of 20 cerebrovascular damage exists.

Pharmaceutical compositions are also included.

The instant invention concerns the use of compounds I for the preparation of pharmaceuticals for cerebral ischemia or cerebral infarction resulting from a range of conditions such as thromboembolic or hemorrhagic stroke, cerebral vasospasm, hypoglycemia, cardiac arrest, status epilepticus, or cerebral 25 trauma. Other treatments are for schizophrenia, neuromuscular disorders, Alzheimer's Disease, or Huntington's Disease.

In Neuropharmacology, Vol. 24, No. 11 (1985), pages 1085-1092 it is reported that the compound 2-amino-6-trifluoromethoxy benzothiazole antagonises excitatory amino acids such as glutamate. However, this does not say anything about its unexpected activity with cerebral infarction or ischemia, stroke, 30 schizophrenia, epilepsy, neuromuscular disorders, Alzheimer's Disease or Huntington's disease. In Vol.24, No.8, page 771 of the same document there are mentioned anesthetic properties of 2-amino-6-trifluoromethoxy-benzothiazole, which seem to be independent of the activities of the present invention.

Formula I is



wherein

45 R¹ and R² may be the same or different and are hydrogen, straight or branched alkyl of from one to six carbon atoms, C₁-C₆ alkyl-C₆-C₁₀ aryl, C₁-C₆ alkenyl, phenyl, CF₃, 50 hydroxy, C₁-C₆ alkoxy, C₁-C₆ alkylthio, C₁-C₆ alkylsulphonyl, CF₃O, at the six position, 55 halogen, nitro, carboxy, C₁-C₆ alkoxy-carbonyl

NR⁵R⁶CO,
 NR⁵R⁶,
 R⁵CONR⁵,
 CN,
 NR⁵R⁶SO₂,
 wherein R⁵ and R⁶ may be the same or different and are hydrogen,
 C₁-C₆ alkyl, or
 C₆-C₁₀ aryl
 R¹ and R² may together form a carbocyclic or methylenedioxy ring;
 R³ is hydrogen;
 R⁴ is hydrogen,
 C₁-C₆ alkyl,
 C₁-C₆ alkyl substituted by a heterocyclic group, or substituted heterocyclic group,
 methyl, up to C₆ cycloalkyl
 benzyl,
 phenethyl,
 phenyl,
 phenyl substituted by,
 halogen,
 C₁-C₆ alkyl
 C₁-C₆ alkoxy
 amino,
 substituted amino,
 carboxy,
 cyano and,
 nitro,
 allyl
 propargyl

with the proviso that R¹, R², and R³ must be hydrogen when R⁴ is other than hydrogen.

The term C₁-C₆ alkyl, except where otherwise stated, is alkyl per se, alkoxy, alkylaryl, alkylthio, alkylsulphonyl, alkoxycarbonyl is alkyl of from one to six carbon atoms and may be straight or branched.

C₁-C₆ Alkenyl means an unsaturated straight or branched chain of from one to six carbon atoms.

C₁-C₆ Aryl in alkylaryl may contain from six to ten atoms and include groups such as phenyl and naphthyl.

C₁-C₆ Alkoxy means groups containing up to six carbon atoms such as methoxy, ethoxy or propyloxy.

Alkoxycarbonyl means an ester group, for example, methyl ester, ethyl ester, benzyl ester.

The term halogen means fluorine, chlorine, bromine, and iodine.

The term up to C₆ carbocyclic means groups containing up to 6 carbon atoms such as, for example, benzene, or cyclohexyl.

The term heterocyclic ring includes 5 and 6-membered saturated compounds such as pyrrolidine, piperidine, and heteroaromatic groups such as pyridine and thiophene.

The term substituted heterocyclic group includes substitution by C₁-C₆ alkyl and alkenyl such as N-methylpyrrolidine and N-allylpyrrolidine.

For R⁴, phenyl may be substituted by halogen, alkyl of from one to six carbon atoms, C₁-C₆ alkoxy, amino, substituted amino, carboxy, cyano, and nitro.

The preferred compounds are those of Formula I wherein

R¹ and R² are hydrogen,
 straight or branched alkyl of from one to six carbon atoms,
 C₁-C₆ alkylaryl,
 C₁-C₆ alkenyl,
 phenyl,
 CF₃
 C₁-C₆ alkoxy,
 C₁-C₆ alkylthio,
 C₁-C₆ alkylsulphonyl,
 CF₃O at the six position,
 halogen,
 nitro,
 NR⁵R⁶,

R^5 CONR⁵, or
 CN;
 R^3 is hydrogen; and
 R^4 is hydrogen,
 5 C₁-C₆ alkyl
 methyl-up to C₆ cycloalkyl, or benzyl,
 2-(1-methyl-2-pyrrolidinyl)ethyl,
 with the proviso that R¹, R², and R³ must be hydrogen when R⁴ is other than hydrogen.
 The more preferred compounds are:
 10 2-aminobenzothiazole,
 2-amino-6-methylbenzothiazole,
 2-amino-4-methylbenzothiazole,
 2-amino-6-trifluoromethylbenzothiazole,
 2-amino-4-trifluoromethylbenzothiazole,
 15 2-amino-5-trifluoromethylbenzothiazole,
 2-amino-6-trifluoromethoxybenzothiazole,
 2-amino-6-ethoxybenzothiazole,
 2-amino-6-nitrobenzothiazole,
 2-amino-4-methoxybenzothiazole,
 20 2-amino-5-methoxybenzothiazole,
 2-amino-4,6-dimethylbenzothiazole,
 2-amino-6-bromobenzothiazole,
 2-amino-6-chlorobenzothiazole,
 2-amino-4-chlorobenzothiazole,
 25 2-amino-6-fluoromethylbenzothiazole,
 2-amino-naphtho[1,2-d]thiazole,
 2-ethylaminobenzothiazole,
 2-[[2-(1-methyl-2-pyrrolidinyl)ethyl]amino]benzothiazole,
 2-amino-6-methylsulphonylbenzothiazole,
 30 2-amino-4,6-difluorobenzothiazole,
 2-amino-6-methylthiobenzothiazole, and
 2-benzylaminobenzothiazole.

Compounds of the instant invention include solvates, hydrates, and salts of the compounds of Formula I above.

35 A compound of Formula I above is useful both in the free base form and in the form of acid addition salts and both forms are within the scope of the invention. The term pharmaceutically acceptable acid addition salt is intended to mean relatively nontoxic acid addition salts from either inorganic or organic acids such as, for example, hydrochloric, hydrobromic, sulfuric, phosphoric, citric, oxalic, malonic, acetic, maleic, salicylic, ethanesulfonic, malic, gluconic, fumaric, succinic, ascorbic, methanesulfonic, benzenesulfonic, or
 40 p-toluenesulfonic as would occur to one skilled in the art.

Pharmaceutically acceptable inorganic and organic basic salts such as sodium, calcium, lithium, potassium, magnesium, ammonium or quaternary ammonium salts, diethylamine, and diethanolamine are also within the scope of the invention.

45 The acid addition salts of the basic compounds are prepared either by dissolving the free base in aqueous or aqueous-alcohol solution or other suitable solvents containing the appropriate acid and isolating the salt by evaporating the solution, or by reacting the free base and acid in an organic solvent, in which case the salt separates directly or can be obtained by concentration of the solution. The basic addition salts are similarly prepared.

50 The compounds used in the invention may contain asymmetric carbon atoms. This invention includes the use of individual enantiomers or diastereomers which may be prepared or isolated by methods known in the art.

The effectiveness of the aforementioned compounds is determined by a pharmacological test procedure as described and illustrated as follows.

55 The procedure is entitled Combined Middle Cerebral and Ipsilateral Common Carotid Occlusion in the Rat as a Screen for Compounds Active in the Treatment of Stroke (MCAO).

Occlusion of the proximal part of the middle cerebral artery (MCA) is a common cause of stroke in man and can be accomplished surgically in experimental animals. This technique, though technically feasible in the rat is very difficult and time-consuming (Tamura, A., Graham, D. I., McCulloch, J., Teasdale, G. M.,

Focal Cerebral Ischemia in the Rat: 1. Description of Technique and Early Neuropathological Consequences Following Middle Cerebral Artery Occlusion. *J. Cereb. Blood Flow Metab.* 1:53-60, 1981). It has been reported that a distal occlusion of the MCA 5 mm from its origin at the circle of Willis does not consistently result in infarction (Coyle, P., Middle Cerebral Artery Occlusion in the Young Rat. *Stroke.* 13:6, 1982). We have combined distal MCA occlusion with ipsilateral common carotid ligation in an attempt to produce reproducible, focal cerebral ischemic infarcts.

Adult male Fisher (F-344) rats (250-300 g) were anesthetized in a box containing halothane and then moved to a small animal anesthetic mask to which 1.5% halothane in room air was provided for spontaneous inspiration (Levy, D. E., Zwies, A., Duffy, T. E., A Mask for Delivery of Inhalation Gases to Small Laboratory Animals. *Laboratory Animal Science*, Volume 30, 5:868-870, 1980). The skin on the ventral side of the neck and the left temporal-parietal region was shaved. An incision was made in the neck and the left common carotid artery was doubly ligated and cut between the sutures. The incision was closed with 4-0 silk. Another incision was then made behind the left eye and the skin was held back with retractors. The exposed temporalis muscle was electrocauterized (Jarit Bipolar Coagulator) and partially removed. The upper part of the lower jaw bone was also removed. Deep surgery was performed with the aid of a Zeiss OPMI 99 surgical microscope. A 1 to 2-mm diameter craniotomy was made about 1 mm anterior to where the rostral end of the zygoma fuses to the squamosal bone. To prevent the drill from going through the dura, the burr hole was not drilled completely through the skull. Bone remaining after drilling was removed with forceps. The dura was pierced and reflected with a fine probe.

At this point the rat was injected with 0.3 ml of 2% Evans blue dye in saline via the tail vein. Evans blue binds to serum albumin and will not pass the blood-brain barrier unless damage has occurred, such as damage induced by ischemia. A small hook was then positioned under the MCA and the MCA was lifted away from the cortex. A jeweler-type bipolar forceps was introduced and the MCA was electrocauterized and separated. Gelfoam was put over the craniotomy and the wound was closed with 4-0 silk. The rats were then taken off the halothane and were allowed to wake up. Total anesthesia time was typically 30 minutes. Animals undergoing this procedure (MCAO rats) awoke from anesthesia within ten minutes of breathing room air alone again and were grossly indistinguishable from unoperated rats.

On Day 2 following MCA occlusion, the rats were anesthetized with ketamine (150 mg/kg, IP) and sacrificed. Cerebral tissue fixation was initiated by perfusion of 10% neutralized, buffered formalin for five minutes. Brains were removed and stored in the fixative until analysis.

For evaluation of the extent of cerebral ischemic injury, the brains were cut coronally in three different locations. The first section was at the level where the MCA was ligated. The other two sections were 2 mm anterior and 2 mm posterior to the first. Using an ausJena Citoval microscope with a drawing tube and an Apple II plus computer with a Houston Instrument digitizing pad, a software routine to measure the area of the ischemic damage as indicated by the extent of Evans blue tissue extravasation was employed. The software package was purchased from R&M Biometrics (Nashville, TN) and is titled Bioquant II. From the lesion areas (mm²) obtained from the Bioquant II program, we estimated the hemispheric extent (mm³) of ischemic damage between the anterior and posterior sections by computing and adding the volume of two truncated cones.

In preliminary experiments the extent of cerebral ischemic injury was compared in MCAO and sham-operated rats. Sham-operated rats underwent an identical surgical procedure except that the bipolar electrocautery forceps were activated away from the artery but within the subarachnoid space.

The area of ischemic damage was significantly larger in the MCAO as compared to the sham-operated rats in the anterior and middle coronal sections, represented both as area of injury and area of injury as a percentage of the entire coronal section. The posterior coronal section showed a tendency toward a larger area of injury in MCAO animals relative to sham-operated controls.

Combined middle cerebral and ipsilateral common carotid artery ligation caused ischemic cerebral tissue injury which was consistently greater in extent than that injury which occurs as a result of sham operation alone. The area of injury was greatest in the anterior and middle coronal sections, which is consistent with the area of middle cerebral arterial distribution in the rat.

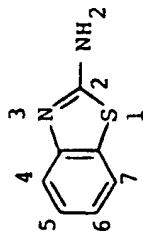
The Bioquant II image analysis system was used to quantitate ischemic injury as it was identified by Evans blue extravasation. The variability in extent of ischemic cerebral tissue injury in this model is small enough that it can be reasonably anticipated that successful treatment can be detected by reduction in the lesion size.

Compounds were administered in solution (the vehicle was saline, pH adjusted to be 3-5, and was without effects in the MCAO assay) by intraperitoneal injection (1.0 ml/kg body weight) 30 minutes and again 24 hours after arterial occlusions.

The duration of anesthesia is that time elapsed between administration of the test substance and the test animal regaining consciousness.

Tables I-IV below show MCAO and anesthetic activity for the disclosed compounds.

TABLE I
AMINOENZOTHIAZOLES: ¹MCAO ACTIVITY
6-Substituted-2-Aminoenzothiazoles
(Page 1 of 2)



Compound Number	R (6-position)	Dose (mg/kg)	² Anesthesia (Yes or No) (duration)	³ Collateral Zone Infarct (% of Control)	⁴ Hemispheric Infarct (% of Control)
1	-H	10	No	36	61
		30	Yes (2 h)	11	47
2	-SMe	10	--	72	88
		30	--	100	106
3	-Me	10	Yes (2-3 h)	54	77
		30	Yes (4-6 h)	14	51
4	-SO ₂ Me	10	No	77	83
		30	No	58	86
5	-Cl	3	No	77	83
		10	No	58	86
	-Cl	10	No	23	63
		30	Yes (>3 h)	31	66
6	-OEt	10	No	94	115
		30	No	16	59

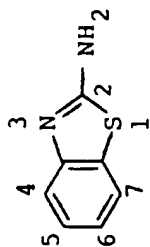
TABLE I
AMINO BENZOTHAZOLE: ¹MCAO ACTIVITY
6-Substituted-2-Aminobenzothiazoles
(Page 2 of 2)

Compound Number	R (6-position)	Dose (mg/kg)	² Anesthesia (Yes or No) (duration)	³ Collateral Zone Infarct (% of Control)	⁴ Hemispheric Infarct (% of Control)
7	-Br	10 30	No Yes (>5 h)	69 59	88 68
8	-NO ₂ (Example 3)	10 30	No Yes (4 h)	92 24	93 62
9	-OCF ₃	3 10 15 30 (N = 2)	No No No Yes (1-2 h)	117 43 42 0	99 66 82 44
10	-CF ₃	3 10	No No	156 51	131 53
11	-F	10 30	No Yes (<4 h)	42 96	76 96

TABLE II

AMINO BENZOTHIAZOLES: 'MCAO ACTIVITY

4-Substituted-2-Aminobenzothiazoles

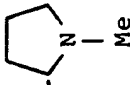


Compound Number	R (4-position)	Dose (mg/kg)	² Anesthesia (Yes or No) (duration)	³ Collateral Zone Infarct (% of Control)	⁴ Hemispheric Infarct (% of Control)
12	-4,6-dimethyl	10 30	No No	91 68	79 76
13	-OMe	3 10	No Yes (>5 h.)	85 115	90 121
14	-Me	10 30	No No	69 40	72 54
15	-Cl	10 30	Yes (2 h.) Yes (>5 h.)	63 15	75 51
16	-CF ₃	10 30	No Yes	63 15	99 61
17	-4,6-difluoro	10 30	No Yes	137 105	139 115

TABLE III
 AMINOENZOTHIAZOLES: ¹MCAO ACTIVITY
 5-Substituted-2-Aminobenzothiazoles

Compound Number	R (5-position)	Dose (mg/kg)	² Anesthesia (Yes or No) (duration)	³ Collateral Zone Infarct (% of Control)	⁴ Hemispheric Infarct (% of Control)
18	-OMe	10 30	No No	124 54	117 82
19	-CF ₃ (Example 7)	10 30	No No	48 53	63 79
20	-4,5-(C ₄ H ₄)	10 30	No Yes	63 81	84 92

TABLE IV
AMINOBENZOTHAZOLE: ¹MCAO ACTIVITY
2-Substituted-benzothiazoles

Compound Number	R	Dose (mg/kg)	² Anesthesia (Yes or No) (duration)	³ Collateral Zone Infarct (% of Control)	⁴ Hemispheric Infarct (% of Control)
21	-NHEt (Example 5)	10 30	No No	62 116	71 89
22	-NHCH ₂ Ph(Example 6)	10 30	No No	56 98	76 89
23	-NHCH ₂ CH ₂ - 	10 30	No No	66 18	84 72

¹ MCAO Activity: Compounds were given IP in solution 30 minutes after stroke onset and again 24 hours later.

² Anesthesia: Yes - Rats showed impaired consciousness and lack of righting reflex after dosing.

No - Rats may have been ataxic but could right themselves and responded to noxious stimuli after dosing.

³ Collateral Zone Infarct: Posterior section of ipsilateral cerebral hemisphere - infarct is measured in mm² and presented as a percentage of respective historical control sections.

⁴ Hemispheric Infarct: Estimated total hemispheric volume measured in mm³ and presented as a percentage of historical controls.

Collateral Zone (C) and Hemispheric (H) Infarct Volumes are expressed as Percent of Historical Control Rats (N = 30) and were measured quantitatively after combined middle cerebral and ipsilateral carotid artery occlusion (MCAO) according to the protocol described above. The collateral zone (posterior cerebral tissue section) was assessed as a specific indicator of injury to an area of the brain away from the arterial occlusion site. The hemispheric volume was an assessment computed from multiple cerebral tissue sections to provide an overall impression of infarct size.

For the therapeutic uses described above, the usual mammalian dosage range for a 70 kg human subject is from 1 to 2100 mg per day or 0.01 mg to 30 mg per kg of weight per day; optionally in divided portions. Determination of the proper dosage for a particular situation is within the skill of the art.

Pharmaceutical compositions of the compound of the present invention or its salts are produced by formulating the active compound in dosage unit form with a pharmaceutical carrier. Some examples of dosage unit forms are tablets, capsules, pills, powders, aqueous and nonaqueous oral solutions, and suspensions and parenteral solutions packaged in containers containing either one or some larger number of dosage units and capable of being subdivided into individual doses. Some examples of suitable pharmaceutical carriers, including pharmaceutical diluents, are gelatin capsules; sugars such as lactose and sucrose; starches such as corn starch and potato starch; cellulose derivatives such as sodium carboxymethyl cellulose, ethyl cellulose, methylcellulose, and cellulose acetate phthalate; gelatin; talc; stearic acid; magnesium stearate; vegetable oils such as peanut oil, cottonseed oil, sesame oil, olive oil, corn oil, and oil of theobroma; propylene glycol; glycerine; sorbitol; polyethylene glycol; water; agar; alginic acid; isotonic saline, and phosphate buffer solutions; as well as other compatible substances normally used in pharmaceutical formulations. The compositions of the invention can also contain other components such as coloring agents, flavoring agents, and/or preservatives. These materials, if present, are usually used in relatively small amounts. The compositions can, if desired, also contain other therapeutic agents.

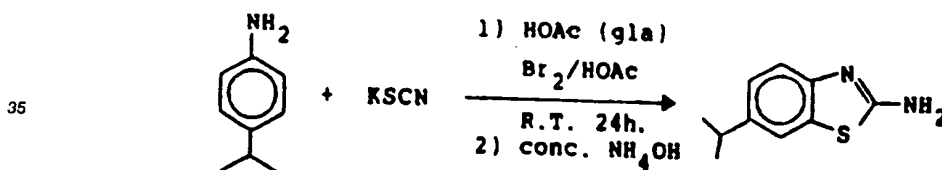
The percentage of the active ingredient in the foregoing compositions can be varied within wide limits, but for practical purposes it is preferably present in a concentration of at least 10% in a solid composition and at least 2% in a primarily liquid composition. The most satisfactory compositions are those in which a much higher proportion of the active ingredient is present.

Routes of administration of the subject compound or its salts are oral, parenteral, transdermal, or intranasal. For example, a useful intravenous dose is between 0.01 and 10.0 mg/kg. A preferred intravenous dose is 0.1 to 5.0 mg/kg. A still further preferred dose is 0.1 to 1.0 mg/kg. A useful oral dose is 0.01 to 30 mg/kg. A preferred oral dose is 0.1 to 10 mg/kg. A further preferred dose is 1.0 to 5.0 mg/kg. All of the above are as would occur to a person skilled in the art.

The following examples are provided to enable one skilled in the art to practice the invention.

Example 1

30



40

To a stirred mixture of 4-isopropylaniline (10.0 g, 0.074 mol) and potassium thiocyanate (14.38 g, 0.148 mol) in 100 mL of glacial acetic acid was added dropwise, bromine (11.83 g, 0.074 mol) in 25 mL glacial acetic acid, over 0.5 hours. The reaction mixture was stirred vigorously for 24 hours at room temperature. The reaction mixture was poured over ice, and the solution made basic to pH 10 with concentrated ammonium hydroxide to produce a yellow precipitate. The 2-amino-6-isopropylbenzothiazole was collected by filtration and recrystallized from toluene (50% yield, m.p. 123-124°C).

50

calc.	C 64.46	H 6.29	N 14.57	S 16.68
found	C 62.44	H 6.32	N 14.60	S 16.65

55

Example 2

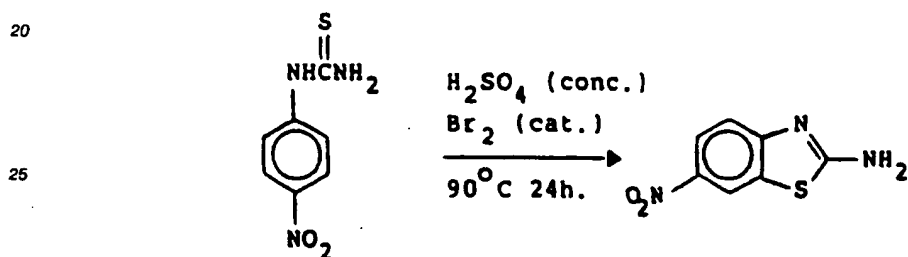


10

To a stirred mixture of 9.3 g (0.074 mol) of 3-fluoro-4-methylaniline and 14.4 g (0.148 mol) potassium thiocyanate in 50 mL glacial acetic acid was added dropwise 11.8 g (0.074 mol) of bromine. The solution was stirred at room temperature for 18 hours. The reaction solution was poured over ice and basified to pH 10 with concentrated ammonium hydroxide to yield a precipitate. The solid, 2-amino-5-fluoro-6-methylbenzothiazole was collected by filtration and recrystallized from ethanol or toluene.

15

Example 3



30

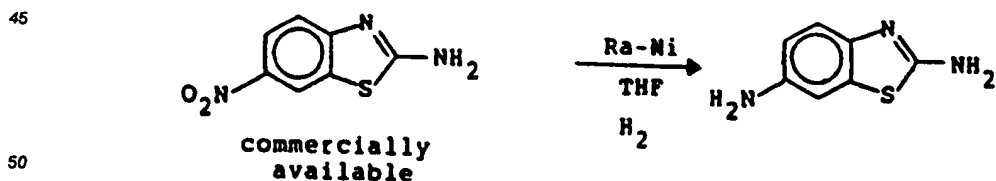
To a stirred mixture of 1-(4-nitrophenyl)-2-thiourea (15.0 g, 0.076 mol) in 20 mL of concentrated sulfuric acid was added dropwise, bromine (0.61 g, 0.004 mol) in 10 mL concentrated sulfuric acid over 0.5 hours. The reaction mixture was heated to 90°C, and stirred vigorously for 24 hours. The reaction was cooled slowly to room temperature and quenched by pouring over ice. The solution was made basic to pH 10 with concentrated ammonium hydroxide, producing a yellow solid. The 2-amino-6-nitrobenzothiazole was filtered and recrystallized from ethanol (85% yield, m.p. 246-247°C).

35

calc.	C 43.07	H 2.58	N 21.53	S 16.43
found	C 42.71	H 2.46	N 21.58	S 16.79

40

Example 4

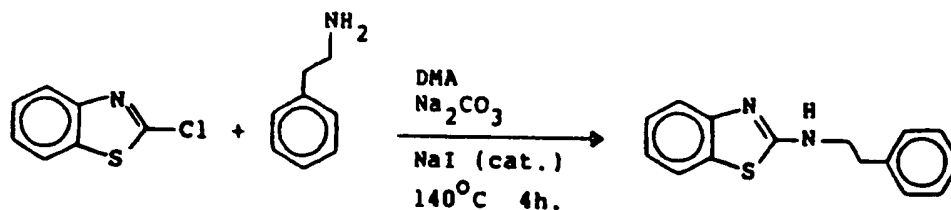


To a solution of 2-amino-6-nitrobenzothiazole (10 g, 0.051 mol) in 100 mL of tetrahydrofuran was added 3.0 g Raney-nickel active catalyst. The reaction mixture was hydrogenated until hydrogen consumption ceased. The reaction mixture was filtered through a Celite pad and the solution was concentrated under reduced pressure to produce a brown solid. The solid was recrystallized from toluene, yielding 2,6-diaminobenzothiazole (50% yield, m.p. 202-203°C).

55

calc.	C 50.88	H 4.27	N 25.43	S 19.41
found	C 50.71	H 4.42	N 25.43	S 19.80

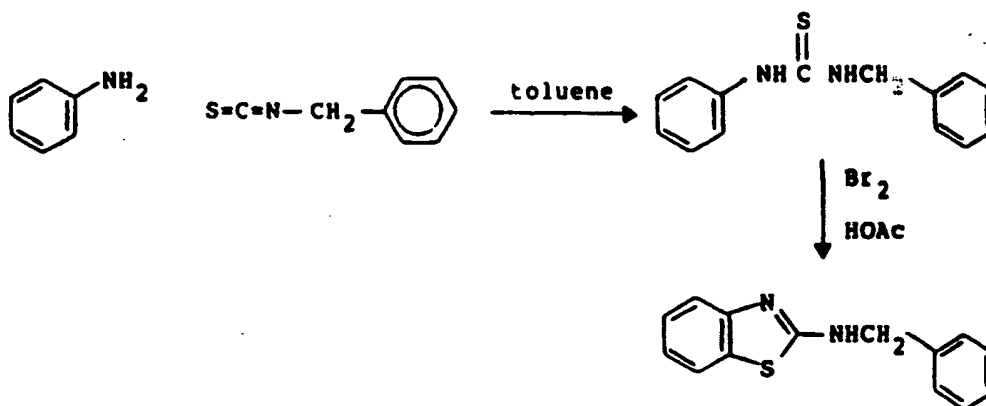
Example 5



To a stirred mixture of 2-chlorobenzothiazole (13.3 g, 0.077 mol), sodium carbonate (9.77 g, 0.092 mol) and sodium iodide (0.22 g, 0.0015 mol) in 15 mL N,N-dimethylacetamide, was added phenethylamine (10.24 g, 0.084 mol) in one portion. The reaction mixture was heated to 140°C, stirred vigorously for four hours and allowed to cool slowly to room temperature. At this time the reaction was quenched with water producing a brown solid. The N-(2-phenethyl)-2-benzothiazolamine was collected by filtration and recrystallized from di-isopropyl ether (8% yield, m.p. 143°C).

calc.	C 70.80	H 5.55	N 11.02	S 12.61
found	C 70.80	H 5.76	N 11.05	S 12.82

Example 6

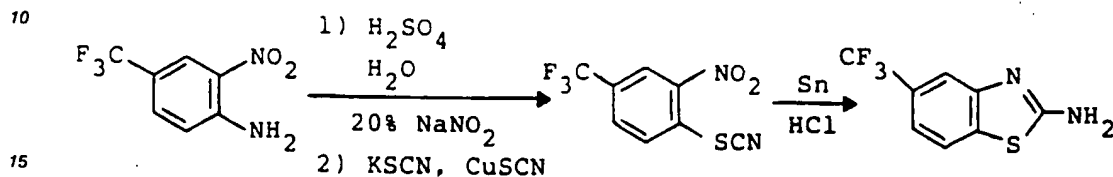


(As illustrative of literature procedures, a further general method for the preparation of the disclosed compounds given here)

To a stirred solution of 74.6 g (0.5 mol) of benzylisothiocyanate in 500 mL toluene was added dropwise 46.6 g (0.5 mol) of aniline. The solution was refluxed 18 hours. After cooling, the reaction mixture was concentrated under reduced pressure. The residue was recrystallized from an appropriate solvent to yield N-phenyl-N'-benzylthiourea. Isothiocyanates which are not commercially available may be prepared from aliphatic or aryl primary amines by the following methods: Kurita and Iwakura, Org. Synth. 59, 195; Jochims, Chem. Ber. 101, 1746 (1968); or Castro, Pena, Santos, and Vega, J. Org. Chem. 49, 863 (1984).

To a stirred solution of 12.1 g (0.05 mol) of N-phenyl-N'-benzylthiourea in 150 ml of glacial acetic acid was added dropwise 8.0 g (0.05 mol) of bromine in 60 mL of glacial acetic acid. The reaction was poured into 10 volumes of water and made basic with concentrated ammonium hydroxide. A solid precipitated from the aqueous solution and was filtered. The solid could be recrystallized from an appropriate solvent to yield N-benzyl-2-benzothiazolamine.

Example 7



3-Nitro-4-thiocyanatobenzotrifluoride

20

To a stirred solution of 20.6 g (0.10 mol) 4-amino-3-nitrobenzotrifluoride in 30 mL conc. H_2SO_4 and 30 mL H_2O at 0°C was added dropwise 37.5 mL 20% sodium nitrite. The mixture was stirred for 90 minutes at $0-5^\circ\text{C}$. Potassium thiocyanate (10 g in 20 mL H_2O) was added dropwise and stirred 15 minutes. The reaction was poured into a vigorously stirred slurry of 18 g (0.148 mol) copperthiocyanate in 60 mL H_2O . Gas evolution began and the mixture foamed. The reaction was stirred two hours at 3°C and then heated to 70°C for 20 minutes. The reaction was cooled to 25°C and stirred an additional 18 hours. The solution was filtered and the water was extracted with toluene (3 x 100 mL). The toluene layer was dried (Na_2SO_4), filtered, and concentrated under reduced pressure to yield a purple oil. The product was purified by silica gel chromatography. The column was eluted initially with hexane followed by hexane/ CH_2Cl_2 (7:3) to yield an oil which was crystallized from heptane to yield a yellow solid, m.p. $72-73^\circ\text{C}$.

calc.	C 38.71	H 1.22	N 11.29
found	C 38.62	H 1.17	N 11.10.

2-amino-5-trifluoromethylbenzothiazole hydrochloride

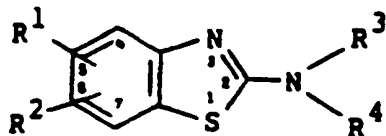
40

To a vigorously stirred solution of 4.0 g (0.16 mol) 3-nitro-4-thiocyanatobenzotrifluoride in 50 mL conc. HCl was added 16.0 g (0.135 mol) granulated tin over one hour. The reaction changed from an orange to very pale yellow to white. The reaction was stirred at 25°C for 20 h. The reaction solution was diluted with H_2O (250 mL) and conc. NH_4OH was added dropwise. The product precipitated along with the tin salts. The solid was filtered and boiled in CHCl_3 (3 x 200 mL). The aqueous layer was extracted with CHCl_3 . All the CHCl_3 washings were combined, dried (MgSO_4), filtered, and concentrated under reduced pressure to yield a dark brown solid. The crude benzothiazole was dissolved in hot Et_2O and filtered. To the filtrate was added a solution of freshly prepared $\text{Et}_2\text{O}/\text{HCl}$. The product precipitate was filtered and washed with Et_2O to yield a white solid m.p. $255-257^\circ\text{C}$.

calc.	C 37.73	H 1.98	N 11.00
found	C 37.50	H 2.33	N 10.76

Claims

1. Use of a compound of the general formula I



I

or of a pharmaceutically acceptable salt thereof wherein R¹ and R² are the same or different and are

hydrogen,

straight or branched alkyl of from one to six carbon atoms,

C₁-C₆ alkyl-C₆-C₁₀ aryl

C₁-C₆ alkenyl,

phenyl,

CF₃,

hydroxy,

C₁-C₆ alkoxy,

C₁-C₆ alkylthio,

C₁-C₆ alkylsulphonyl,

CF₃O at the six position,

halogen,

nitro,

carboxy,

C₁-C₆ alkoxy-carbonyl,

NR⁵R⁶CO,

NR⁵R⁶,

R⁵CONR⁵,

CN,

NR⁵R⁶SO₂,

wherein R⁵ and R⁶ may be the same or different and are hydrogen,

C₁-C₆ alkyl, or

C₆-C₁₀ aryl;

R¹ and R² may together form a carbocyclic or methylenedioxy ring;

R³ is hydrogen;

R⁴ is hydrogen,

C₁-C₆ alkyl,

C₁-C₆ alkyl substituted by a substituted or unsubstituted heterocyclic group,

methylcycloalkyl, the cycloalkyl containing up to 6 carbon atoms

benzyl,

phenethyl,

phenyl,

substituted phenyl,

C₁-C₆-alkyl

propargyl

with the proviso that R¹, R², and R³ must be hydrogen when R⁴ is not hydrogen, for the preparation of a pharmaceutical for treating cerebral ischemia or cerebral infarction, stroke, schizophrenia, neuromuscular disorders, Alzheimer's Disease or Huntington's Disease.

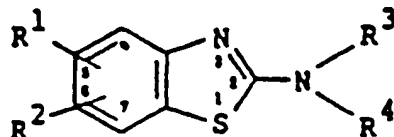
2. Use according to Claim 1 wherein the compound I is a member selected from the group consisting of
- 2-amino-6-methylbenzothiazole,
- 2-amino-6-trifluoromethoxybenzothiazole,
- 2-amino-6-trifluoromethylbenzothiazole,

- 2-aminobenzothiazole,
 2-amino-4-methylbenzothiazole,
 2-amino-6-ethoxybenzothiazole,
 2-amino-6-nitrobenzothiazole,
 5 2-amino-5-methoxybenzothiazole,
 2-amino-6-methylsulphonylbenzothiazole,
 2-amino-4,6-dimethylbenzothiazole,
 ethylaminobenzothiazole,
 2-benzylaminobenzothiazole,
 10 2-amino-4-trifluoromethylbenzothiazole,
 2-amino-5-trifluoromethylbenzothiazole,
 2-amino-6-bromobenzothiazole,
 2-amino-6-chlorobenzothiazole,
 2-amino-4-chlorobenzothiazole,
 15 2-amino-6-fluorobenzothiazole,
 2-amino-5-methoxybenzothiazole,
 2-amino-4,6-difluorobenzothiazole,
 2-amino-6-methylthiobenzothiazole,
 2-amino-naphtho[1,2-d]thiazole, and
 20 2-[[2-(1-methyl-2-pyrrolidiny)ethyl]amino]-benzothiazole.

3. Use of a compound of Claim 1 for the preparation of an anesthetic pharmaceutical in surgical operations, where a risk of cerebrovascular damage exists.

25 Patentansprüche

1. Verwendung einer Verbindung der allgemeinen Formel I



oder eines pharmazeutisch akzeptablen Salzes hiervon,
 worin bedeuten:

R¹ und R², die gleich oder verschieden sind,
 Wasserstoff,

40 gerad- oder verzweigt-kettiges Alkyl mit 1 bis 6 Kohlenstoffatom(en),

C₁-C₆-Alkyl-C₆-C₁₀-Aryl,

C₁-C₆-Alkenyl,

Phenyl,

45 CF₃,

Hydroxy,

C₁-C₆-Alkoxy,

C₁-C₆-Alkylthio,

C₁-C₆-Alkylsulfonyl,

50 CF₃O in 6-Stellung,

Halogen,

Nitro,

Carboxy,

C₁-C₆-Alkoxy-carbonyl,

55 NR⁵ R⁶ CO,

NR⁵ R⁶,

R⁵ CONR⁵,

CN,

NR⁵R⁶SO₂

mit R⁵ und R⁶, die gleich oder verschieden sein können, gleich Wasserstoff,
C₁-C₆-Alkyl oder

C₆-C₁₀-Aryl oder

5 R¹ und R² zusammen einen carbocyclischen oder Methylendioxyring,

R³ Wasserstoff,

R⁴ Wasserstoff,

C₁-C₆-Alkyl,

10 durch eine gegebenenfalls substituierte heterocyclische Gruppe substituiertes C₁-C₆-Alkyl,

Methylcycloalkyl mit bis zu 6 Kohlenstoffatomen in der Cycloalkyleinheit,

Benzyl,

Phenethyl,

Phenyl,

substituiertes Phenyl,

15 C₁-C₆-Alkyl,

Propargyl,

wobei gilt, daß R¹, R² und R³ Wasserstoff sein müssen, wenn R⁴ von Wasserstoff verschieden ist,

zur Herstellung eines Arzneimittels zur Behandlung von zerebraler Ischämie oder zerebralem
Infarkt, Schlaganfall, Schizophrenie, neuromuskulären Störungen, Alzheimer'scher Krankheit oder Hun-
20 tington'scher Krankheit.

2. Verwendung nach Anspruch 1, wobei die Verbindung I aus einer Verbindung, ausgewählt aus der Gruppe

2-Amino-6-methylbenzothiazol,

25 2-Amino-6-trifluormethoxybenzothiazol,

2-Amino-6-trifluormethylbenzothiazol,

2-Aminobenzothiazol,

2-Amino-4-methylbenzothiazol,

2-Amino-6-ethoxybenzothiazol,

30 2-Amino-6-nitrobenzothiazol,

2-Amino-5-methoxybenzothiazol,

2-Amino-6-methylsulfonylbenzothiazol,

2-Amino-4,6-dimethylbenzothiazol,

2-Ethylaminobenzothiazol,

35 2-Benzylaminobenzothiazol,

2-Amino-4-trifluormethylbenzothiazol,

2-Amino-5-trifluormethylbenzothiazol,

2-Amino-6-brombenzothiazol,

2-Amino-6-chlorbenzothiazol,

40 2-Amino-4-chlorbenzothiazol,

2-Amino-6-fluorbenzothiazol,

2-Amino-5-methoxybenzothiazol,

2-Amino-4,6-difluorbenzothiazol,

2-Amino-6-methylthiobenzothiazol,

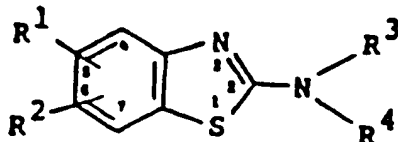
45 2-Amino-naphtho[1,2-d]thiazol und

2-[[2-(1-Methyl-2-pyrrolidiny)ethyl]amino]-benzothiazol,
besteht.

3. Verwendung einer Verbindung nach Anspruch 1 zur Herstellung eines anästhetischen Arzneimittels bei
50 chirurgischen Operationen, bei denen ein Risiko eines zerebrovaskulären Schadens besteht.

Revendications

1. Utilisation d'un composé représenté par la formule générale I:



dans laquelle:

R¹ et R², qui peuvent être identiques ou différents l'un de l'autre, représentent un atome d'hydrogène, un radical alkyle linéaire ou ramifié comportant 1 à 6 atomes de carbone, un radical C₁-C₆-alkyl-C₆-C₁₀-aryle, un radical C₁-C₆-alkényle, phényle, un groupe CF₃, hydroxy, un radical C₁-C₆-alkoxy, C₁-C₆-alkylthio, C₁-C₆-alkylsulfonyle, CF₃O en position 6, un atome d'halogène, un groupe nitro, carboxy, un radical C₁-C₆-alkoxy-carbonyl, un groupe NR⁵R⁶CO, NR⁵R⁶, R⁵CONR⁵, CN, CR⁵R⁶SO₂;

dans lesquels:

R⁵ et R⁶, qui peuvent être identiques ou différents l'un de l'autre, représentent un atome d'hydrogène, un radical C₁-C₆-alkyle, ou un radical C₆-C₁₀-aryle;

R¹ et R² peuvent former ensemble un cycle carbocyclique ou méthylènedioxy;

R³ représente un atome d'hydrogène;

R⁴ représente un atome d'hydrogène, un radical C₁-C₆-alkyle, un radical C₁-C₆-alkyle substitué par un groupe hétérocyclique ou un groupe hétérocyclique substitué, un groupe méthylcycloalkyle dont la partie cycloalkyle contient jusqu'à 6 atomes de carbone; un groupe benzyle, phénéthyle, phényle, phényle substitué, un radical C₁-C₆-alkyle; propargyle;

à condition que R¹, R² et R³ doivent représenter des atomes d'hydrogène lorsque R⁴ n'est pas à un atome d'hydrogène;

ou d'un sel pharmaceutiquement acceptable en dérivant, pour la préparation d'un composé pharmaceutique pour le traitement de l'ischémie cérébrale; l'infarctus cérébral, d'attaque, de schizophrénie, de troubles neuro-musculaires, de la maladie d'Alzheimer ou de la maladie de Huntington.

2. Utilisation selon la revendication 1, dans laquelle le composé I est un dérivé sélectionné dans le groupe consistant en:

2-amino-6-méthylbenzothiazole,

2-amino-6-trifluorométhoxybenzothiazole,

2-amino-6-trifluorométhylbenzothiazole,

2-aminobenzothiazole,

2-amino-4-méthylbenzothiazole,

2-amino-6-éthoxybenzothiazole,

2-amino-6-nitrobenzothiazole,

2-amino-5-méthoxybenzothiazole,

2-amino-6-méthylsulfonylbenzothiazole,

2-amino-4,6-diméthylbenzothiazole,

éthylaminobenzothiazole,

2-benzylaminobenzothiazole.

2-amino-4-trifluorométhylbenzothiazole,

2-amino-5-trifluorométhylbenzothiazole,

2-amino-6-bromobenzothiazole,

2-amino-6-chlorobenzothiazole,

2-amino-4-chlorobenzothiazole,

2-amino-6-fluorobenzothiazole,

2-amino-5-méthoxybenzothiazole,

2-amino-4,6-difluorobenzothiazole,

2-amino-6-méthylthiobenzothiazole,

2-amino-naphto[1,2-d]thiazole, et
2-[[2-(1-méthyl-2-pyrrolidiny)éthyl]amino]-benzothiazole.

3. L'utilisation d'un composé selon la revendication 1, pour la préparation d'un produit pharmaceutique
5 anesthésique dans les interventions chirurgicales, où un risque de lésion cérébrovasculaire existe.

10

15

20

25

30

35

40

45

50

55